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Appl. No. 10/520,563

Reply to Office action of 12/07/2007

Amendment to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1 (currently amended): A method for using a heat treatment atmosphere cocatalyst in an apparatus comprising heat treatment equipment or heat treatment-gas producing equipment having an atmosphere, the method comprising:

dissolving or dispersing the cocatalyst into a heat treatment atmosphere material to produce a ~~combination~~ mixture, the cocatalyst existing in the form of a gas phase or a very fine dispersion in the heat treatment atmosphere material; and

diffusing said ~~combination~~ mixture into the atmosphere of the heat treatment equipment or heat treatment gas-producing equipment.

Claim 2 (previously presented): The method of claim 1 wherein the cocatalyst is diffused directly into the heat treatment atmosphere material in the form of a gas phase or a very fine dispersion, or the cocatalyst is dissolved or dispersed into a carrying agent to produce an admixture, and said admixture is fed into heat treatment equipment or heat treatment gas-producing equipment.

Claim 3 (canceled)

Claim 4 (canceled)

Claim 5 (withdrawn): A cocatalyst for a heat treatment atmosphere material, the cocatalyst comprising two or more components selected from the group consisting of:

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a halogen element compound which takes 0.1-4% by weight in the heat treatment atmosphere material;

a metal element compound which takes 0.0003-0.03% by weight in the heat treatment atmosphere material; and

a nitrogen compound which takes 1-10% by weight in the heat treatment atmosphere material;

wherein said metal element compound is one or more than one compound selected from the group consisting of cobalt naphthenate, manganese naphthenate, nickel nitrate, manganese nitrate, ferrocene, and ferrocene ramification;

wherein said halogen element compound is one or more than one compound selected from the group consisting of chlorobenzene, trichlorobenzene, chlorotoluene, nitrochlorobenzene, trichloroethylene, ribromomethane, iodine, iodinated oil, iodomethane, freone, and tetrafluoroethylene;

wherein said nitrogen compound is one or more than one compound selected from the group consisting of p-amino-azobenzene hydrochloride, nitrobenzene, toluenediisocyanate, nitrochlorobenzene, trinitrobenzene, melamine, tricyanic acid, dicyandiamide, guanidine nitrate, cyclotrimethylenetrinitramine, pyridine, pyrazol, and pyraze; and

wherein said cocatalyst is capable of being maintained in the form of a gas phase or a very fine dispersion in the heat treatment atmosphere material.

Claim 6 (withdrawn): The heat treatment atmosphere cocatalyst according to claim 5, further comprising:

a rare earth compound comprising lanthanum or cerium which takes 0.1-3% by weight in the heat treatment atmosphere material;

wherein said rare earth compound is selected from the group consisting of cerium naphthenate, lanthanum naphthenate, cerium nitrate, lanthanum nitrate, lanthanum chloride, cerium chloride, lanthanum fluoride, and cerium fluoride.

Claim 7 (previously presented): A method for atmosphere heat treatment of a metal material, said method comprising:

heat treating the metal material in a heat treatment atmosphere with a cocatalyst or an active heat treatment atmosphere produced by said cocatalyst;

wherein said cocatalyst is diffused into said heat treatment atmosphere in the form of a gas phase or a very fine dispersion, and releases a substance that activates the heat treatment atmosphere.

Claim 8 (canceled)

Claim 9 (canceled)

Claim 10 (canceled)

Claim 11 (canceled)

Claim 12 (canceled)

Claim 13 (withdrawn): The cocatalyst of claim 5 wherein the cocatalyst comprises at least one component selected from the group consisting of:

a halogen element compound which takes 0.1-1% by weight in the heat treatment atmosphere material;

a metal element compound which takes 0.0003-0.015% by weight in the heat treatment atmosphere material; and

a nitrogen compound which takes 1-2% by weight in the heat treatment atmosphere material.

Claim 14 (withdrawn): The cocatalyst of claim 5 wherein:

said metal element compound is at least one compound selected from the group consisting of: ferrocene, and ferrocene ramification;

said halogen element compound is at least one compound selected from the group consisting of: chlorobenzene, trichlorobenzene, chlorotoluene, and nitrochlorobenzene; and

said nitrogen compound is at least one compound selected from the group consisting of: p-amino-azobenzene hydrochloride, nitrobenzene, toluenediisocyanate, nitrochlorobenzene, trinitrobenzene, guanidine nitrate, and cyclotrimethylenetrinitramine.

Claim 15 (withdrawn): A composition of matter for catalyzing a reaction in a heat treatment atmosphere, said composition of matter comprising at least two components selected from the group consisting of:

a halogen element compound which takes 0.1-4% by weight in the heat treatment atmosphere;

a metal element compound which takes 0.0003-0.03% by weight in the heat treatment atmosphere; and

a nitrogen compound which takes 1-10% by weight in the heat treatment atmosphere; wherein said metal element compound is at least one compound selected from the group consisting of: cobalt naphthenate, manganese naphthenate, nickel nitrate, manganese nitrate, ferrocene, and ferrocene ramification;

wherein said halogen element compound is at least one compound selected from the group consisting of: chlorobenzene, trichlorobenzene, chlorotoluène, nitrochlorobenzene, trichloroethylene, ribromomethane, iodine, iodinated oil, iodomethane, freone, and tetrafluoroethylene;

wherein said nitrogen compound is at least one compound selected from the group consisting of: p-amino-azobenzene hydrochloride, nitrobenzene, toluenediisocyanate, nitrochlorobenzene, trinitrobenzene, melamine, tricyanic acid, dicyandiamide, guanidine nitrate, cyclotrimethylenetrinitramine, pyridine, pyrazol, and pyraze; and

wherein said cocatalyst is capable of existing in the form of a gas phase or a very fine dispersion in the heat treatment atmosphere.

Claim 16 (previously presented): A method for making a heat treatment atmosphere, said method comprising:

combining the composition of matter of claim 15 with a heat treatment atmosphere material.

Claim 17 (previously presented): A method for ~~heating~~ heat treating a metal, said method comprising:

exposing the metal to the composition of matter of claim 15 in an apparatus comprising heat treatment equipment under conditions that are operative to achieve heat treatment.

Claim 18 (currently amended): A method for making a heat treatment atmosphere, said method comprising:

combining the composition of matter of claim 15 with a carrying agent to produce a ~~combination~~ mixture; and

dispersing the ~~combination~~ mixture in a heat treatment atmosphere material.

Claim 19 (previously presented): A method for ~~heating~~ heat treating a metal, said method comprising:

exposing the metal to a cocatalyst in an apparatus comprising heat treatment equipment containing heat treatment atmosphere material under conditions that are operative to achieve heat treatment;

said cocatalyst comprising two or more components selected from the group consisting of:

a halogen element compound which takes 0.1-4% by weight in the heat treatment atmosphere material;

a metal element compound which takes 0.0003-0.03% by weight in the heat treatment atmosphere material; and

a nitrogen compound which takes 1-10% by weight in the heat treatment atmosphere material;

wherein said metal element compound is one or more than one compound selected from the group consisting of cobalt naphthenate, manganese naphthenate, nickel nitrate, manganese nitrate, ferrocene, and ferrocene ramification;

wherein said halogen element compound is one or more than one compound selected from the group consisting of chlorobenzene, trichlorobenzene, chlorotoluene,

nitrochlorobenzene, trichloroethylene, ribromomethane, iodine, iodinated oil, iodomethane, freone, and tetrafluoroethylene;

wherein said nitrogen compound is one or more than one compound selected from the group consisting of p-amino-azobenzene hydrochloride, nitrobenzene, toluenediisocyanate, nitrochlorobenzene, trinitrobenzene, melamine, tricyanic acid, dicyandiamide, guanidine nitrate, cyclotrimethylenetrinitramine, pyridine, pyrazol, and pyraze; and

wherein said cocatalyst is capable of being maintained in a gas phase or as a very fine dispersion in said heat treatment atmosphere material.

Claim 20 (previously presented): A method for ~~heating~~ heat treating a metal, said method comprising:

exposing the metal to a heat treatment cocatalyst in an apparatus comprising heat treatment equipment that contains a heat treatment atmosphere material under conditions that are operative to achieve heat treatment;

said heat treatment cocatalyst comprising two or more components selected from the group consisting of:

a halogen element compound which takes 0.1-4% by weight in said heat treatment atmosphere material;

a metal element compound which takes 0.0003-0.03% by weight in said heat treatment atmosphere material, and

a nitrogen compound which takes 1-10% by weight in said heat treatment atmosphere material;

wherein said metal element compound is one or more than one compound selected from the group consisting of cobalt naphthenate, manganese naphthenate, nickel nitrate, manganese nitrate, ferrocene, and ferrocene ramification;

wherein said halogen element compound is one or more than one compound selected from the group consisting of chlorobenzene, trichlorobenzene, chlorotoluene, nitrochlorobenzene, trichloroethylene, ribromomethane, iodine, iodinated oil, iodomethane, freone, and tetrafluoroethylene;

wherein said nitrogen compound is one or more than one compound selected from the group consisting of p-amino-azobenzene hydrochloride, nitrobenzene, toluenediisocyanate, nitrochlorobenzene, trinitrobenzene, melamine, tricyanic acid, dicyandiamide, guanidine nitrate, cyclotrimethylenetrinitramine, pyridine, pyrazol, and pyraze; and

said heat treatment cocatalyst further comprises:

a rare earth compound comprising lanthanum or cerium which takes 0.1-3% by weight in the heat treatment atmosphere material;

wherein said rare earth compound is selected from the group consisting of cerium naphthenate, lanthanum naphthenate, cerium nitrate, lanthanum nitrate, lanthanum chloride, cerium chloride, lanthanum fluoride, and cerium fluoride; and

wherein said heat treatment cocatalyst is capable of being maintained in a gas phase or as a very fine dispersion in said heat treatment atmosphere material.

Claim 21 (currently amended): The method of claim 7 wherein said heat treating step is carried out in heat treatment equipment having heat treatment gas-producing equipment and said cocatalyst is dissolved or dispersed into a carrying agent to produce a ~~combination~~ mixture and said ~~combination~~ mixture is fed into said heat treatment gas-producing equipment or heat treatment equipment.

Claim 22 (previously presented): The method of claim 7 wherein said cocatalyst is the cocatalyst of claim 5.

Claim 23 (previously presented): The method of claim 7 further comprising:

carburizing or carbonitriding said metal material at a carbon potential, expressed in percent units, that is about 0.15 percent units to about 0.25 percent units higher than would be used in the absence of said cocatalyst.

Claim 24 (new): A method for atmosphere heat treatment of a metal material, said method comprising:

heat treating the metal material in a heat treatment atmosphere with a cocatalyst or an active heat treatment atmosphere produced by said cocatalyst;

wherein said cocatalyst is diffused into said heat treatment atmosphere in the form of a very fine dispersion, and releases a substance that activates the heat treatment atmosphere.

Claim 25 (new): The method of claim 24 wherein said heat treating step is carried out in heat treatment equipment having heat treatment gas-producing equipment and said cocatalyst is dissolved or dispersed into a carrying agent to produce a mixture and said mixture is fed into said heat treatment gas-producing equipment or heat treatment equipment.